

Remarks

Claims 1-21, 27, and 28 were pending in the subject application. Applicants gratefully acknowledge the Examiner's withdrawal of the rejection under 35 USC §112, second paragraph. By this Amendment, claims 1, 14, and 21 have been amended, claims 4, 27, and 28 have been canceled, and new claim 29 has been added. Support for the amendments and new claim can be found throughout the subject specification and in the claims as originally filed. For example, support for the amendments to independent claims 1 and 21 can be found at page 11, line 10; page 4, lines 30-31; page 6, lines 21-22; and page 5, line 24 of the subject specification; and in claim 4 (now cancelled). Entry and consideration of the amendments presented herein is respectfully requested. Accordingly, claims 1-3, 5-21, and 29 are currently before the Examiner for consideration. Favorable consideration of the pending claims is respectfully requested.

Claims 1, 8-12, 17, 19, 21, and 27 are rejected under 35 USC §102(b) as anticipated by Tiwari (U.S. Patent No. 4,882,032). Applicants respectfully traverse this ground of rejection.

Applicants respectfully assert that the Tiwari patent does not teach or suggest Applicants' claimed invention. As set forth in the Abstract, the Tiwari patent describes a probe for the determination of the hydrogen content of molten aluminium comprising a Ca/CaH<sub>2</sub> reference material and a solid-state electrolyte such as calcium hydride, calcium hydrochloride or strontium hydrochloride. Claim 1 of the present application requires that the content and/or the spatial distribution of oxygen in the reference standard is predetermined to render the solid electrolyte substantially chemically stable in the presence of the reference material. The Examiner asserts in the Office Action that the sensor in the Tiwari patent must include this feature because the Tiwari patent discloses "a fully functioning sensor," even though the Tiwari patent does not mention the oxygen content of the sensor. Applicants respectfully assert that the Examiner's position overlooks the fact that in the sensor of the Tiwari patent, the reference standard materials and the solid electrolyte materials are thermodynamically stable in contact with each other. For example, in the specific embodiment in the Tiwari patent, the reference standard comprises Ca and CaH<sub>2</sub> and the solid electrolyte is CaH<sub>2</sub>. These materials are thermodynamically stable in contact with each other, as can readily be understood from the binary Ca-H phase diagram. Therefore, it is a fundamental

characteristic of the sensor of the Tiwari patent that the contact between reference material and electrolyte is thermodynamically stable.

As described in the subject specification, an object of the present invention is to overcome a problem of chemical reaction (or thermodynamic instability) between certain reference standards and oxygen-based proton-conducting solid electrolytes that was identified by the inventors. The independent claims have been amended herein to clarify this point, by specifying that the solid electrolyte is an oxide-based proton-conducting solid electrolyte and that the reference standard comprises titanium, zirconium or hafnium, or an alloy of titanium, zirconium or hafnium. In the Tiwari patent, the solid electrolyte is not oxide-based and the reference standard is formed from Ca, and not from titanium, zirconium, or hafnium. Thus, the Tiwari patent does not teach or suggest each and every element of Applicants' claimed invention.

In view of the amendments presented herein, Applicants maintain that the teaching in the Tiwari patent is not relevant to the present invention. First, in the sensor of the Tiwari patent, the contact between the reference standard and the electrolyte is thermodynamically stable, because they are made of the same materials. Accordingly, there is no requirement to have any oxygen, or a pre-determined amount or distribution of oxygen, in the reference standard in order to achieve a stable contact between the reference standard and the electrolyte. In addition, if there were a quantity of oxygen in the reference standard, it would simply form CaO, which is a completely inert phase under the operating conditions of the sensor. In other words, the presence or absence of CaO is irrelevant with respect to the functioning of the sensor of the Tiwari patent. Therefore, Applicants respectfully disagree with the Examiner's assertion that a fully functioning sensor must automatically have a suitable oxygen content or oxygen distribution in the reference standard, because there are sensor types in which oxygen is not required or in which it is irrelevant. The sensor of the Tiwari patent is an example of this, and in such cases the oxygen issue is simply irrelevant or non-existent.

As the Examiner is aware, in order to anticipate, a single reference must disclose within the four corners of the document each and every element and limitation contained in the rejected claim. *Scripps Clinic & Research Foundation v. Genentech Inc.*, 18 USPQ2d 1001, 1010 (Fed. Cir. 1991). Applicants respectfully assert that the Tiwari patent does not teach or suggest each and every element of Applicants' claimed invention. Moreover, Applicants note that independent claims 1 and 21 have

been amended to incorporate the elements of dependent claim 4, *i.e.*, to specify that the reference standard comprises titanium, zirconium or hafnium or an alloy of titanium, zirconium or hafnium. Claim 4 was not included under the §102 rejection and, therefore, Applicants respectfully assert that the rejection has been rendered moot. Accordingly, reconsideration and withdrawal of the rejection under 35 USC §102(b) is respectfully requested.

Claims 2, 3, 13, and 28 are rejected under 35 USC §103(a) as obvious over Tiwari (U.S. Patent No. 4,882,032) in view of Kiode *et al.* (U.S. Patent No. 5,445,725). Claim 4 is rejected under 35 USC §103(a) as obvious over the Tiwari patent in view of Alberti *et al.* (U.S. Patent No. 5,453,172). Claims 5 and 6 are rejected under 35 USC §103(a) as obvious over the Tiwari patent and Alberti *et al.* (U.S. Patent No. 5,453,172) as evidenced by Wetch *et al.* (U.S. Patent No. 4,127,443). Claim 14 is rejected under 35 USC §103(a) as obvious over the Tiwari patent and Kiode *et al.* (U.S. Patent No. 5,445,725) as evidenced by Ferro (2008). Claims 15 and 16 are rejected under 35 USC §103(a) as obvious over the Tiwari patent and Kiode *et al.* (U.S. Patent No. 5,445,725) in view of Bode (U.S. Patent No. 4,174,258). Claims 7, 18, and 20 are rejected under 35 USC §103(a) as obvious over the Tiwari patent. Applicants respectfully traverse these grounds of rejection.

Applicants respectfully assert that the cited references, taken alone or in combination, do not teach or suggest the claimed invention. Applicants hereby incorporate in full their remarks addressing the Tiwari patent in the rejection under 35 USC §102 in regard to these rejections under 35 USC §103. Thus, Applicants respectfully assert that the Tiwari patent does not teach or suggest the claimed invention.

The Koide *et al.* patent, which is cited as a secondary reference in several of the §103 rejections, teaches a sensor structure in which perovskites, and specifically doped strontium cerate, barium cerate or calcium zirconate, are used as the solid electrolyte. The Examiner asserts that it would have been obvious to the ordinarily skilled person to modify the sensor of the Tiwari patent by using the doped strontium proton conductor of the Koide *et al.* patent with the Ca/CaH<sub>2</sub> reference standard of the Tiwari patent, “because the substitution of one known proton conductor for another yields a predictable result, as it is used for the same purpose in both sensors.” Applicants respectfully submit that this is incorrect, because a contact between a Ca/CaH<sub>2</sub> reference standard

and an oxidic perovskite solid electrolyte is no longer thermodynamically stable. The Ca metal is highly reactive and will decompose the oxidic perovskite.

Moreover, as noted previously herein, independent claims 1 and 21 have been amended to incorporate the elements of dependent claim 4, *i.e.*, to specify that the reference standard comprises titanium, zirconium or hafnium or an alloy of titanium, zirconium or hafnium. Thus, the amended claims do not include the Examiner's proposed combination of the reference standard of the Tiwari patent and the solid electrolyte of the Koide *et al.* patent. Therefore, all of the §103 rejections that did not include claim 4 have been rendered moot by the amendments presented herein.

However, claim 4 was rejected under §103 over the Tiwari patent in view of the Alberti *et al.* patent. Under this rejection, the Examiner argues that it would have been obvious for the skilled person to take the sensor of the Tiwari patent and to modify it by replacing the Ca/CaH<sub>2</sub> reference standard of the Tiwari patent with the TiH reference standard of the Alberti *et al.* patent, on the basis that because both of these materials function as reference standards, their substitution would yield predictable results. Applicants respectfully disagree and assert that the reference standard and the solid electrolyte materials would not be thermodynamically stable in contact with each other at the operating temperature of the sensor. Moreover, this combination is now excluded from the independent claims because the solid electrolyte of the Tiwari patent is not an oxide-based solid electrolyte. In addition, the independent claims of the subject application specify that the operating temperature of the sensor is above 500°C and the Alberti *et al.* patent does not describe a sensor capable of operating at these temperatures.

The Examiner's arguments outlined above are based on the idea that it is possible for an ordinarily skilled artisan to refer to any reference describing hydrogen sensors, and then simply to take any solid reference standard and combine it with any solid electrolyte, and to conclude that it would be obvious that the new combination would form a functioning sensor. Applicants respectfully assert that if this were correct, then it would be extremely easy to design new sensors, which is not the case. In practice, the fact that reference standard "A" in combination with solid electrolyte "B" is described in the prior art as forming a functioning sensor, and that reference standard "C" in combination with solid electrolyte "D" is described as forming a functioning sensor, does not mean that the combination of A and D or the combination of B and C will form functioning

sensors. The present invention illustrates this point. When an oxide-based proton-conducting solid electrolyte is used in combination with a reference standard comprising titanium, zirconium or hafnium, or an alloy of titanium, zirconium or hafnium, then the inventors have found that a functional sensor may not result. The inventors tried for some time to develop such a sensor but found that the material of the reference standard reacted with and damaged the oxide-based solid electrolyte. After considerable effort, the inventors found that the solution to this problem was that the content and/or the spatial distribution of oxygen in the reference standard must be predetermined to render the solid electrolyte substantially chemically stable in the presence of the reference material, as is recited in independent claims 1 and 21. This is discussed in more detail in the published PCT application from page 6, line 17, to page 7, line 5. There is nothing in any of the references cited under the §103 rejections that teaches Applicants' solution to the problem.

As the Examiner is aware, in order to support a *prima facie* case of obviousness, a person of ordinary skill in the art must generally find both the suggestion of the claimed invention, and a reasonable expectation of success in making that invention, solely in light of the teachings of the prior art and from the general knowledge in the art. *In re Dow Chemical Co.*, 5 USPQ2d 1529, 1531 (Fed. Cir. 1988). One finds neither the suggestion, nor the reasonable expectation of success, of Applicants' claimed invention in the cited references. Accordingly, reconsideration and withdrawal of the rejections under 35 USC §103(a) is respectfully requested.

It should be understood that the amendments presented herein have been made solely to expedite prosecution of the subject application to completion and should not be construed as an indication of Applicants' agreement with or acquiescence in the Examiner's position.

In view of the foregoing remarks and amendments to the claims, Applicants believe that the currently pending claims are in condition for allowance, and such action is respectfully requested.

The Commissioner is hereby authorized to charge any fees under 37 CFR §§1.16 or 1.17 as required by this paper to Deposit Account 19-0065.

Applicants invite the Examiner to call the undersigned if clarification is needed on any of this response, or if the Examiner believes a telephonic interview would expedite the prosecution of the subject application to completion.

Respectfully submitted,



Doran R. Pace  
Patent Attorney  
Registration No. 38,261  
Phone No.: 352-375-8100  
Fax No.: 352-372-5800  
Address: Saliwanchik, Lloyd & Saliwanchik  
A Professional Association  
P.O. Box 142950  
Gainesville, FL 32614-2950

DRP/mv